17.14 A REALTIME INTERNET BASED APPLICATION FOR THE ARCHIVAL, QUALITY CONTROL AND ANALYSIS OF HURRICANE SURFACE WIND OBSERVATIONS

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1. INTRODUCTION

This paper describes the design, implementation and usage of HRD's application for the real-time storage, graphical quality control and analysis of hurricane surface wind observations, H*WIND. Unlike its filesystem based predecessor, WANDA ("Wind Analysis Distributed Application") (Amat, 1998) the front end and the database interface for this system are portable across various architectures and accessible over Intranet/Internet connections. Furthermore, the use of a database management system also facilitates the use of this application for research purposes. The project employed an Object Oriented iterative development method from beginning to end and its implementation primarily features the Java programming language.

An H*WIND quality control or "QCClient" session consists of fetching and selecting desired observation platform types (Air Force/NOAA Aircraft, CMAN, Metar, Buoys, Satellites, GPS Dropwindsondes, etc.) to be viewed from the database and determining a storm track based time window for viewing the data. All observations of the selected types are then plotted in a storm relative view for the chosen time window and geography is positioned for the storm-center time about which an objective analysis can be performed. Users then make decisions about data validity through visual nearest-neighbor comparison and inspection and suggestions from the QCClient's built in validation system. The quality controlled data set or "QCSet" is then committed to the database relating edited observations and storm track fixes with their original values. A user can trigger a run of an objective analysis of any QCSet, real-time or historical, through the QCClient interface.

The analysis programs reside on a UNIX server (Solaris or HPUX) and are made accessible to the client across the network through the use of an object request broker (a CORBA ORB) or through Java's Remote Method Invocation (RMI) framework. Those legacy analysis components, written in FORTRAN77, are wrapped in Java objects and distributed such that each wrapped object acts as an agent for the scientific code that it contains and has access to the other objects in the system. Analysis results are stored in the database, as well, where they are then made available to routines for generating graphical products and gridded products based on the wind field.

2. LIMITATIONS OF THE EXISTING SYSTEM

Although very useful, the current system has some inherent limitations. Firstly, the use of flat file data archives marries the application to a specific filesystem and, at the same time, raises data integrity and security issues. For example, under UNIX, a developer must take measures to set the correct file protection modes on any archived data, and a separate group for HWIND's users is necessary for minimal archive data security. Secondly, lack of portability, an inherent problem in most compiled applications, is amplified in this case through the use of code specific to the NextStep environment. A third limitation lies in the method of distribution of the analysis processes. A more robust method than using ftp, rsh, rcp and VMS DCL script can and should be used.

3. H*WIND DESIGN

3.1 *REQUIREMENTS*

Preliminary meetings with HRD personnel coupled with the experience gained through the development of the initial version of H*WIND (WANDA) helped produce a minimal list of product expectations. The Quality Control system should, in general, provide the following functionality with no precedence implied by the order:

a) Provide database connectivity to the subsystem. H*WIND should be treated as a "database-centric application".
b) Plot atmospheric event (specifically tropical cyclone) data in and synoptic (earth relative) storm relative coordinates along with an optional storm track.
c) Provide a query mechanism for storm track selection.

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d) Provide a query mechanism for measurement platform (e.g. specific aircraft, satellite or ground based platforms) and physical observation selection (e.g. temperature, wind speed, pressure, etc.).
e) Provide both real-time (operational) and post storm (research) modes for storm track and data selection. Using a database makes this task much easier than attempting the same task with only flat files.
f) Provide accurate geographical features (maps) behind the plot.
g) Provide a query mechanism for geographic region and geographic data selection.
h) Provide a query mechanism for individual datum inspection (including storm track fixes).
i) Provide a mechanism for data edition, creation and removal. This includes storm track fixes and atmospheric data, but not geographic data. An existing database schema (Morisseau-Leroy, 1997) makes provisions for these functions.
j) Provide zooming and distance calculation features for the plot and geography.
k) Provide a mechanism to alert the user of any new data that has arrived at the database during the session. This feature may not be absolutely necessary, and may be considered a luxury.

4. PROGRAM DESCRIPTION

4.1 *INTIALIZATION*

An H*WIND session begins with an empty QCClient window. The user's default ocean basin map is loaded at start time through a separate thread of execution. Threading is used so that the user may continue his work without waiting for the basin to load. We will use the Atlantic basin for our example.

4.2 *QCSETS*

To begin data inspection and edition, a QCSet must either be created or loaded from the database or filesystem. QCSets serve to hold data in memory. These data include a list of wind observations, a table containing any edited wind observations, a list of QCSetErrors for holding any reports generated by the experimental automated quality control system and, optionally, but most commonly, a storm track and a storm name. The QCSet also keeps track of the current plot mode (synoptic or storm relative) and is responsible for fetching and inserting QCSets and their components from and into the H*WIND database and/or the filesystem. Once a new or previously archived QCSet is loaded, the user may freely inspect, edit, add to or remove all or part of its included data. All data are plotted as wind barbs over the geography in the main window.

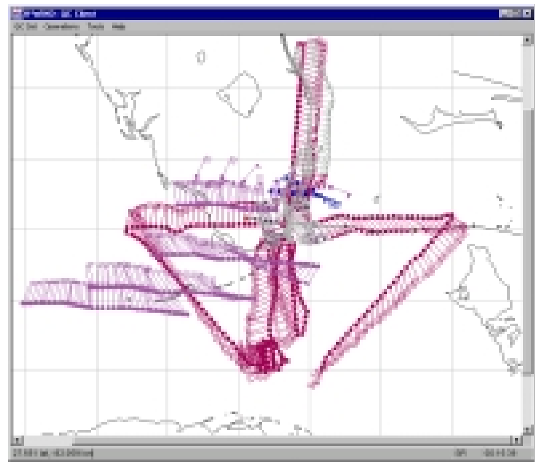


Figure 1. Quality Control plot window in a storm relative mode for Hurricane Andrew near landfall in 1992.

4.3 *TOOLS*

H*WIND users are presented with various tools to facilitate their quality control tasks. These tools include a zoom tool, a location tool, an arbitrary distance and heading tool, an individual wind observation inspection and editing panel (Figures 2 and 3), and a wind observation group flagging and unflagging tool. The flagging serves to designate a group of observation that will not be included in the final version of this QCSet, and, consequently, those that will be omitted in any analysis of this QCSet's data.

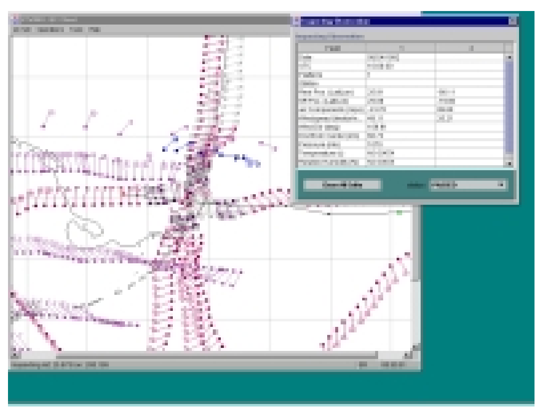


Figure 2. WindObservation Inspection Panel and Plot Window

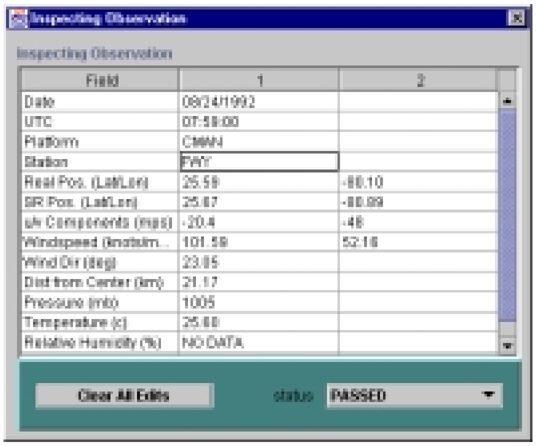
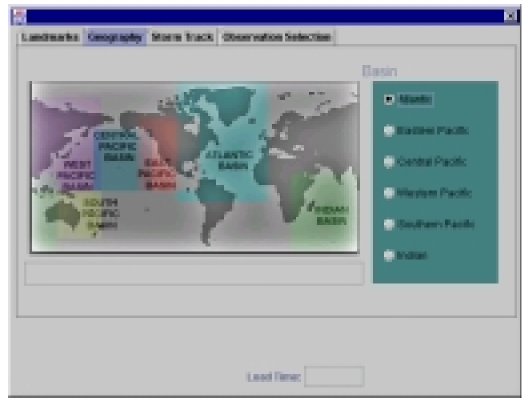


Figure 3. Close Up of WindObservation Inspection Panel

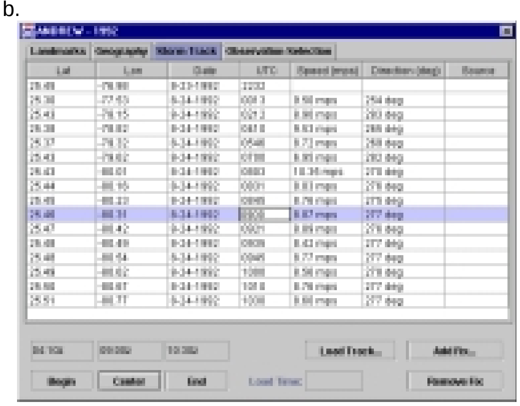
4.4 *DATA VIEWS*

In addition to tools for zooming, inspecting and distance and heading calculation, the user may optionally invoke a separate window containing detailed user views of the data contained in a QCSet. The four main views include the StormTrack view, WindObservation view, Geography view and the Landmark view. The StormTrack view (Figure 4b) displays all the information about each of the storm track fixes contained in the current storm track. It also provides the user with tools to edit, add (via interpolation, extrapolation, load from database or manual entry) and remove fixes as well as tools for loading entire storm tracks from the database into the current QCSet. The WindObservation view (Figure 4c) dynamically displays all the different observation platforms represented by the data in the current QCSet (Air Force and NOAA reconnaissance aircraft, satellites, CMAN stations, buoys, ships, airport reports, etc.) and details about those data groups. These details include the number of observations currently loaded for a given platform, the time range for the observations, the specified time scope for inclusion into the QCSet, whether or not the data are to be included in the QCSet and the color used to draw data that came from the given platform. The Geography view (Figure 4a) allows the user to select the current basin he wishes to view. This view is only available in the synoptic plot mode. The Landmark view displays the number and type of landmarks, user defined points of interest to be plotted over the geography, currently loaded into memory as well as their display colors.

a.



b.



c.

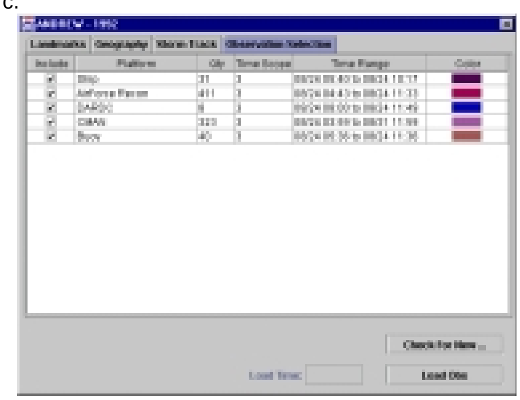


Figure 4. The main Data Views: a) Geography View, b) StormTrack View, c) WindObservation View,

4.5 *COMMITAL AND ANALYSIS*

Once the user has finished evaluating the data in the QCSet, he may commit (save) the QCSet to the database or discard the QCSet and changes made throughout the session. The user must commit the QCSet if he chooses to send it to an analysis server to undergo an objective analysis. Two methods of object distribution are currently available for the analysis subsystem: one involving CORBA (Common Object Request Broker Architecture) and one involving Java RMI

(Remote Method Invocation). The scenario, however, is the same regardless of which method is used. In either case, the client contacts the analysis server and passes along all the parameters it needs to run an analysis. The analysis server then fetches the specified QCSet from the database and runs the analysis. When the analysis is completed, the results are then committed to the database and related to the input QCSet and parameters for research and product generation purposes.

4.6 ***PRODUCT GENERATION***

H*WIND's product generation phase is not yet automated. The analysis results can currently be fed, however, to several IDL (Interactive Data Language from Research Systems, Inc.) programs that generate various products such as streamline and isotach plots and wind swaths (Figures 5 and 6). Analysis results are rich data sets representing many fields, so there is a great potential for different products to assist forecasters, emergency managers and scientists.

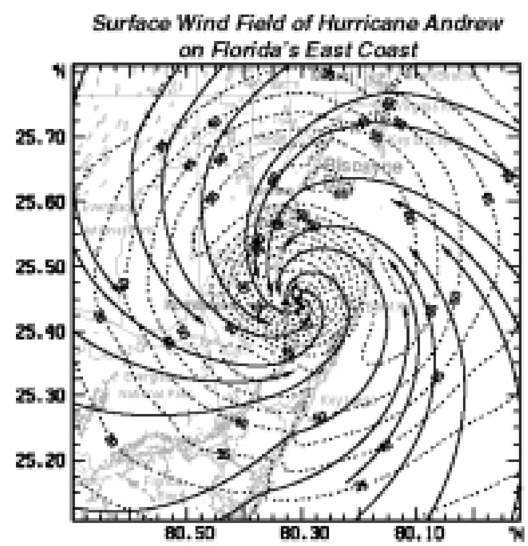


Figure 5. Hurricane Andrew Surface Winds (ms^{-1})

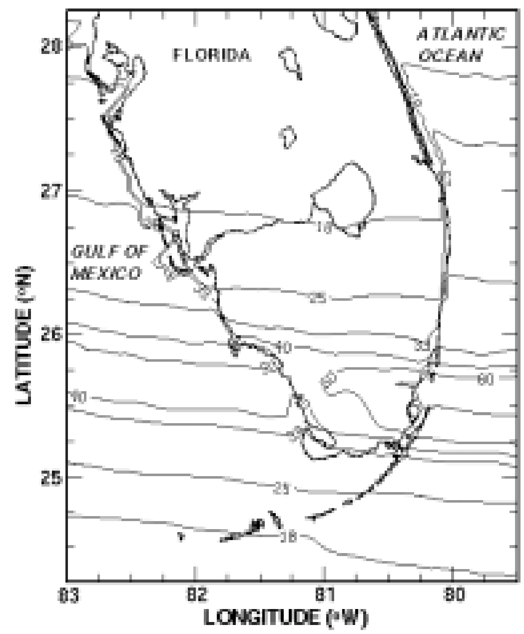


Figure 6. Hurricane Andrew Wind Swath (ms^{-1})

5. REFERENCES

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